

THE CHRONOLOGY OF LARGE LUNAR IMPACTS AND THE LATE HEAVY BOMBARDMENT HYPOTHESIS. C. H. Lineweaver^{1,2} and M. Norman¹, ¹Planetary Science Institute of the Research School of Earth Sciences and the Research School of Astronomy and Astrophysics, Australian National University, Canberra, ACT, Australia, ²charley@mso.anu.edu.au

Life arose on Earth about 4 billion years ago. As planetary accretion slowed and then came to an end, the heavy bombardment of the Earth may have played a formative role in the impact frustration and origin of life [1]. The best way we have of quantifying the decrease of the bombardment -- our best bombardometer—is the relative and absolute chronology of the largest impact craters on the Moon. A late heavy bombardment between ~3.75 Gyr and ~3.95 Gyr has been hypothesized to explain the clustering of crystallization ages of impact melt breccias from the near-side equatorial regions of the Moon. Whether this clustering reflects a geographical selection effect or a real peak in the bombardment rate is the subject of much debate, e.g. [2].

We evaluate the long-term lunar impact flux using crater densities preserved within large basins. Our analysis provides strong evidence for a steep cratering flux early in the stratigraphic sequence of lunar basins but the implications for changes in the cratering flux through time depends on the absolute ages of lunar basins, which are not well established [3]. A late heavy bombardment would be strongly supported if the South Pole Aitken (SPA) basin, stratigraphically the oldest basin on the Moon, has an absolute age not much older than the younger basins (i.e. ~ 4 Ga) [4]. Older assumed ages for SPA (e.g. 4.4 Ga or 4.2 Ga) produce cratering flux curves indicating an early heavy bombardment, and weaker evidence for a late heavy bombardment. However, the absolute age of stratigraphically intermediate basins such as Nectaris play a more dominant role in interpreting the cratering evidence for a late cataclysm.

Quantitative ages for any of these intermediate basins would vastly improve our understanding of the impact history of the lunar crust and the early Earth, and provide a better test of the late heavy bombardment hypothesis.

References: [1] Maher, K.A. & Stevenson, D.J. (1988) *Nature*, 331, 612 [2] Chapman C.R. et al. (2007) *Icarus* 189, 233-245. [3] Norman, M. & Lineweaver, C.H. (2008) Australian Space Science Conference Series: 7th Conference Proceedings, National Space Society of Australia, in press [4] Wilhelm, D.E. (1987) U.S. Geological Survey, Professional Paper 1348. [4].